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[54] **LIQUID SPRAYING APPARATUS AND A METHOD OF MANUFACTURING THE LIQUID SPRAYING APPARATUS**

[75] Inventors: **Kazuo Sanada**; **Hiroshi Inoue**, both of Kanagawa, Japan

[73] Assignee: **Fuji Photo Film Co., Ltd.**, Kanagawa, Japan

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[51] **Int. Cl.**[7] **B05B 1/28**; B05B 1/08; B41J 2/135; B41J 2/045

[52] **U.S. Cl.** **239/104**; 239/102.1; 239/102.2; 347/45; 347/47; 347/70

[58] **Field of Search** 239/104, 102.1, 239/102.2; 347/45, 70, 71, 40, 47

[56] **References Cited**

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Primary Examiner—Andres Kashnikow
Assistant Examiner—Robin O. Evans
Attorney, Agent, or Firm—Sughrue, Mion, Zinn, Macpeak & Seas, PLLC

[57] **ABSTRACT**

A liquid spraying apparatus according to the present invention comprises a spray tank which stores an image forming solvent, a nozzle plate which is provided as a portion of the wall surface of the spray tank, and has a plurality of nozzle holes formed thereon for spraying the image forming solvent, and which can spray the image forming solvent from the plurality of nozzle holes through a reciprocating movement, and a water repelling layer which is provided on the internal periphery of the nozzle holes of the nozzle plate and repels the image forming solvent.

28 Claims, 13 Drawing Sheets

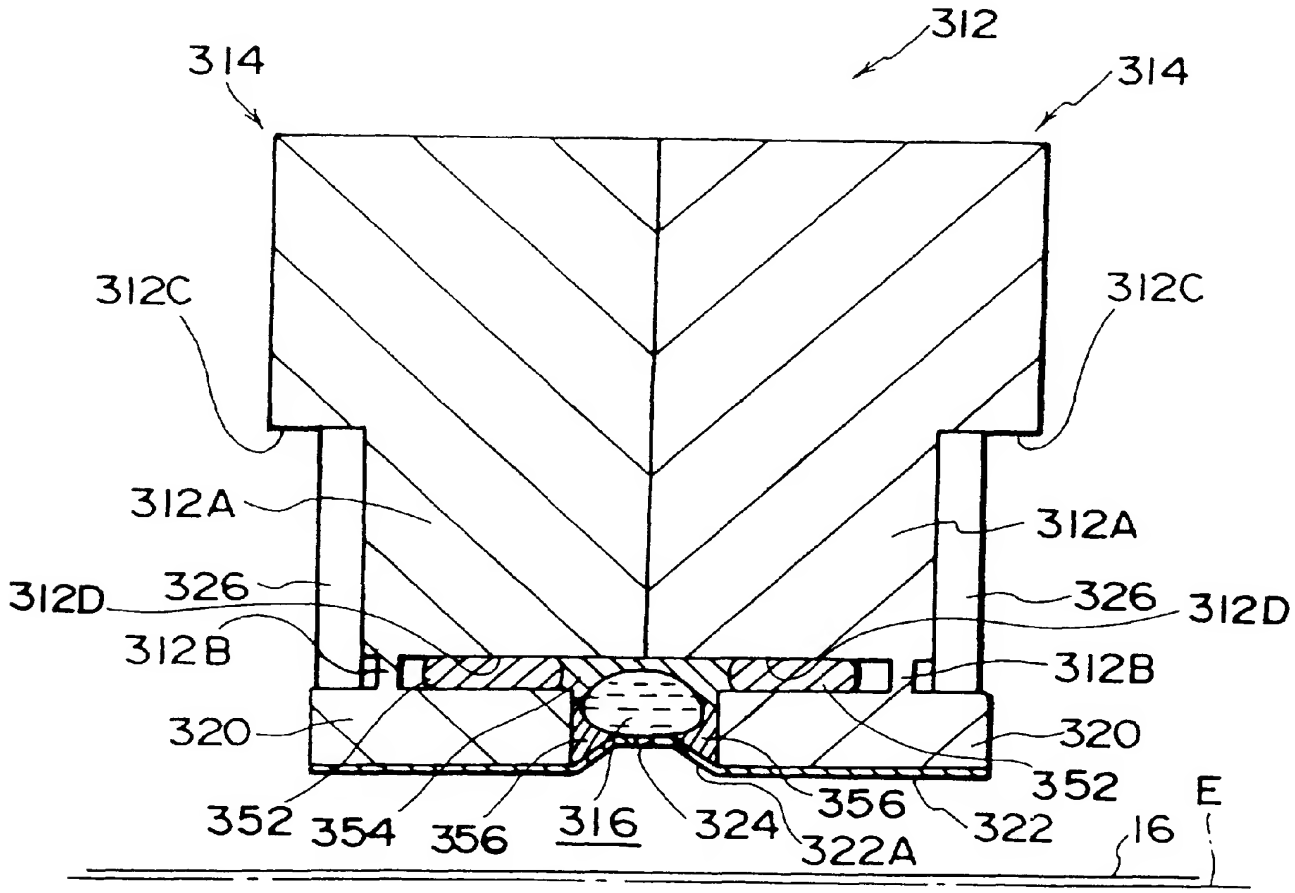

FIG. 1

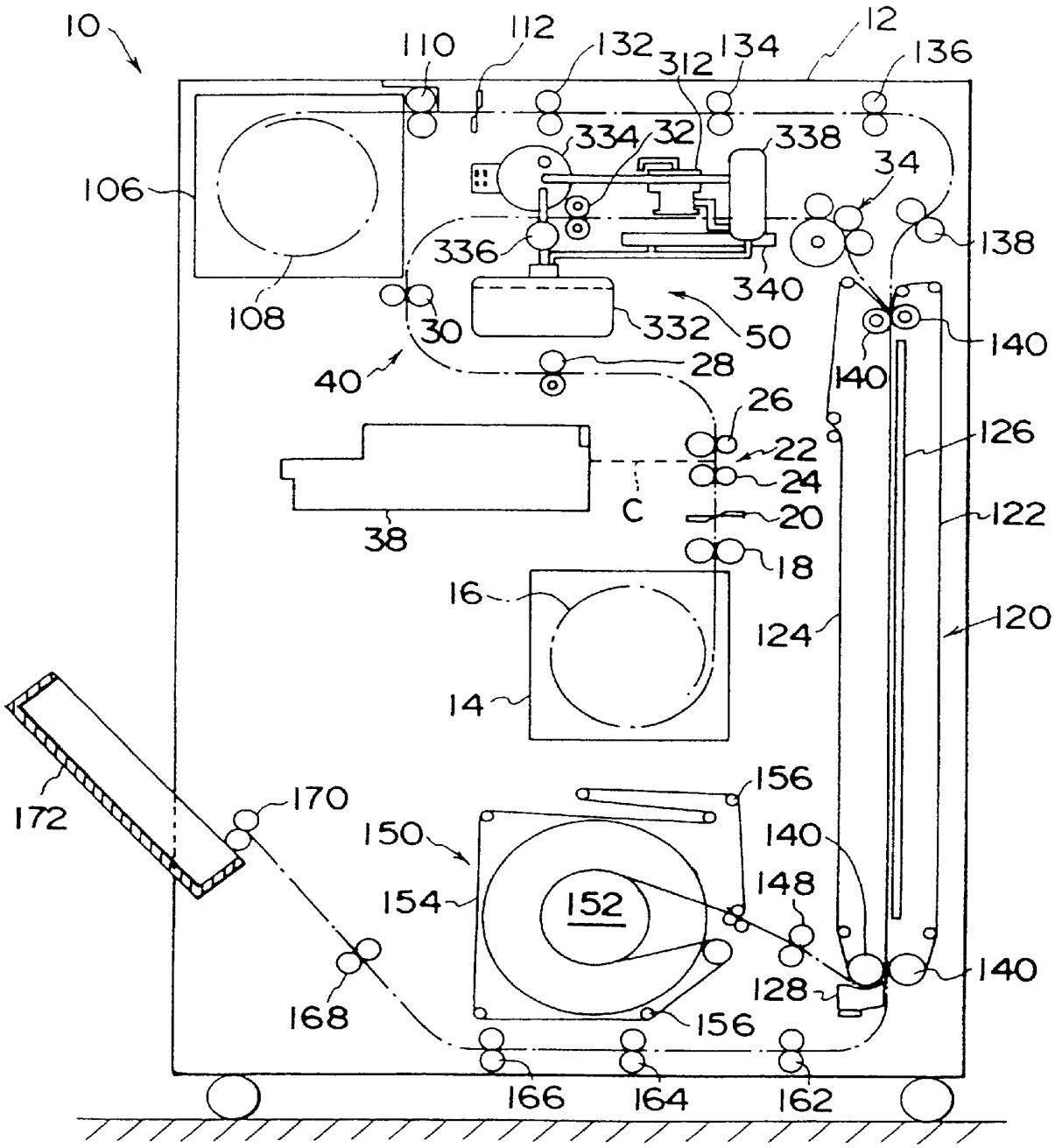
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FIG. 2

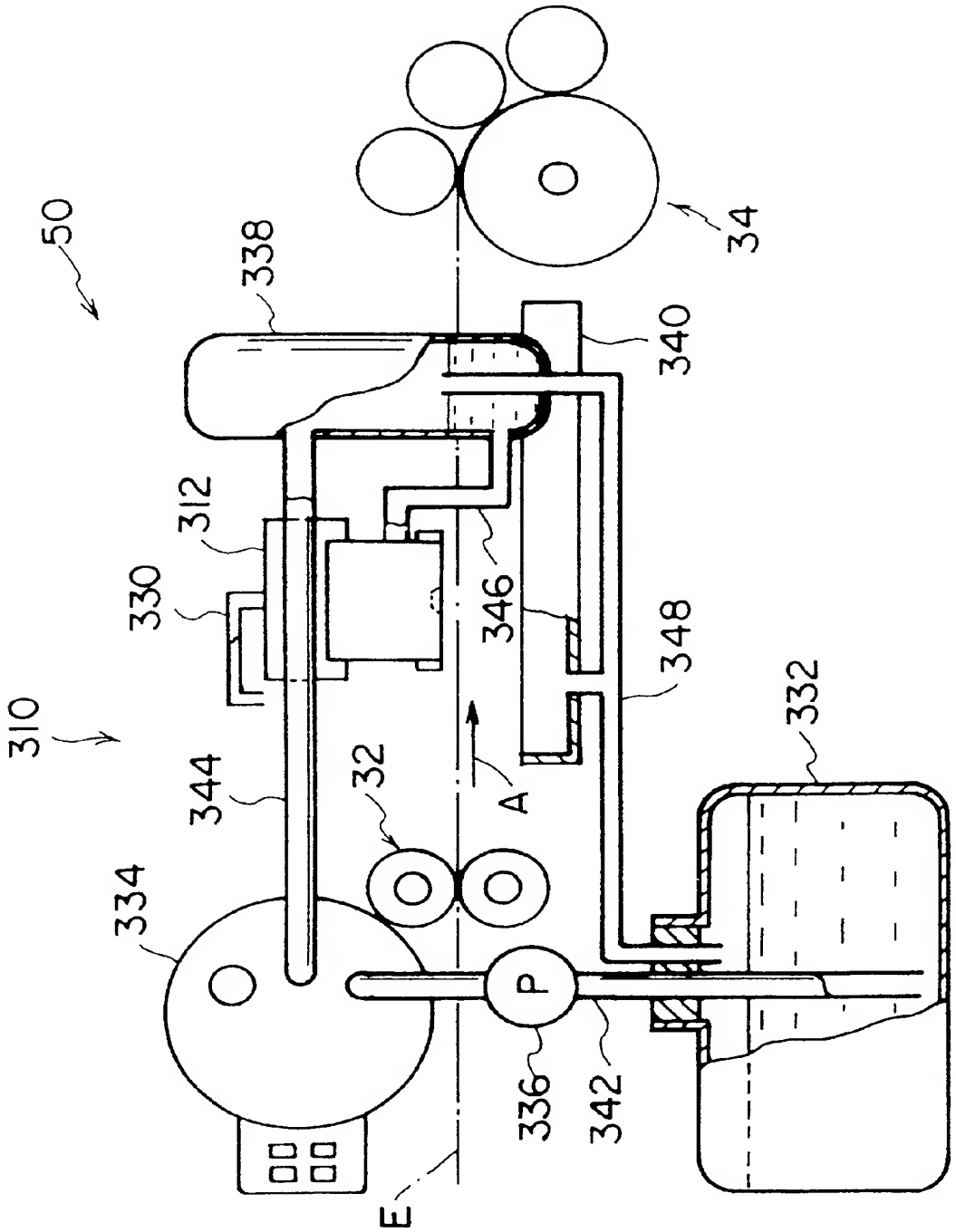
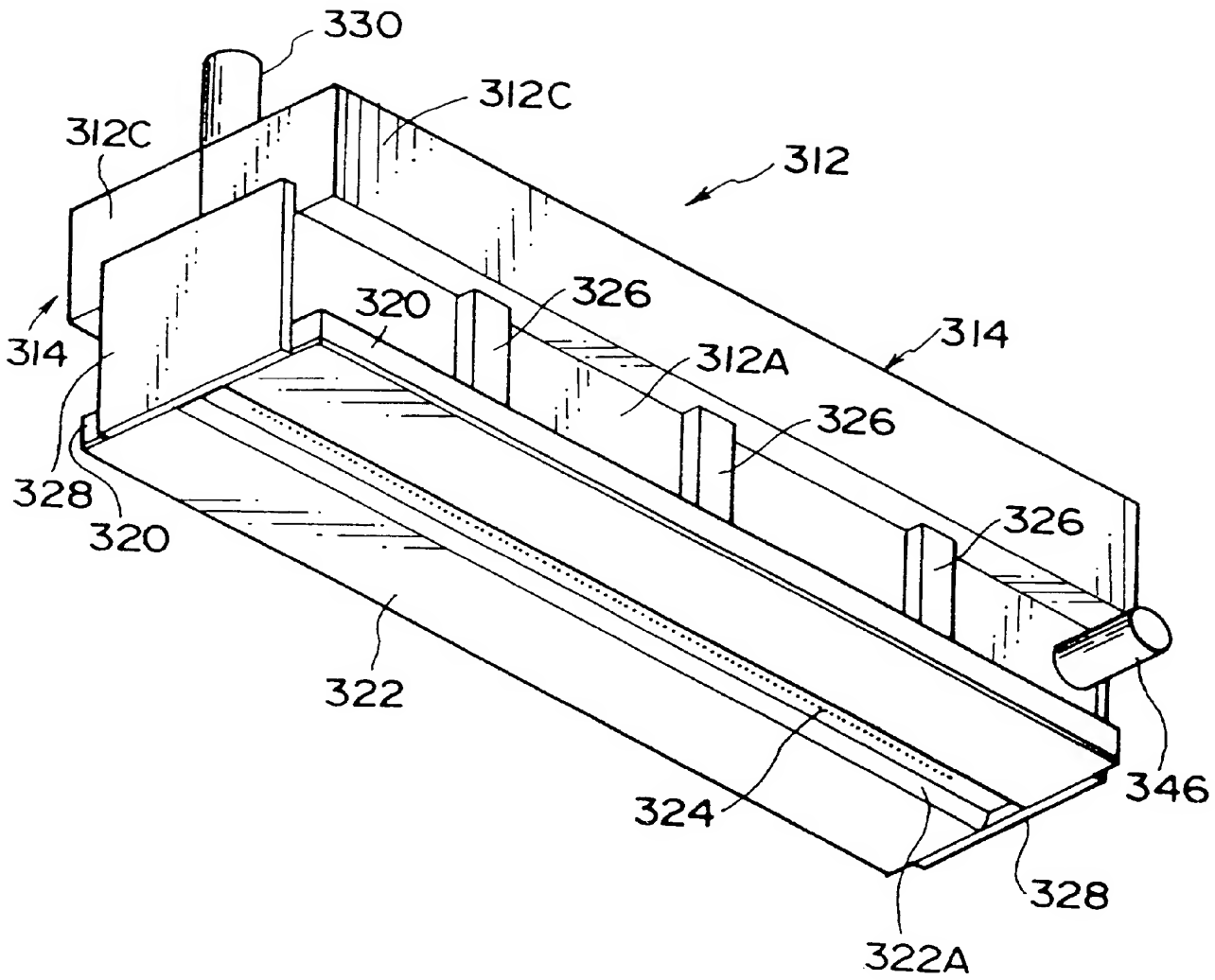


FIG. 3


330
312C
312C
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322A

FIG. 4

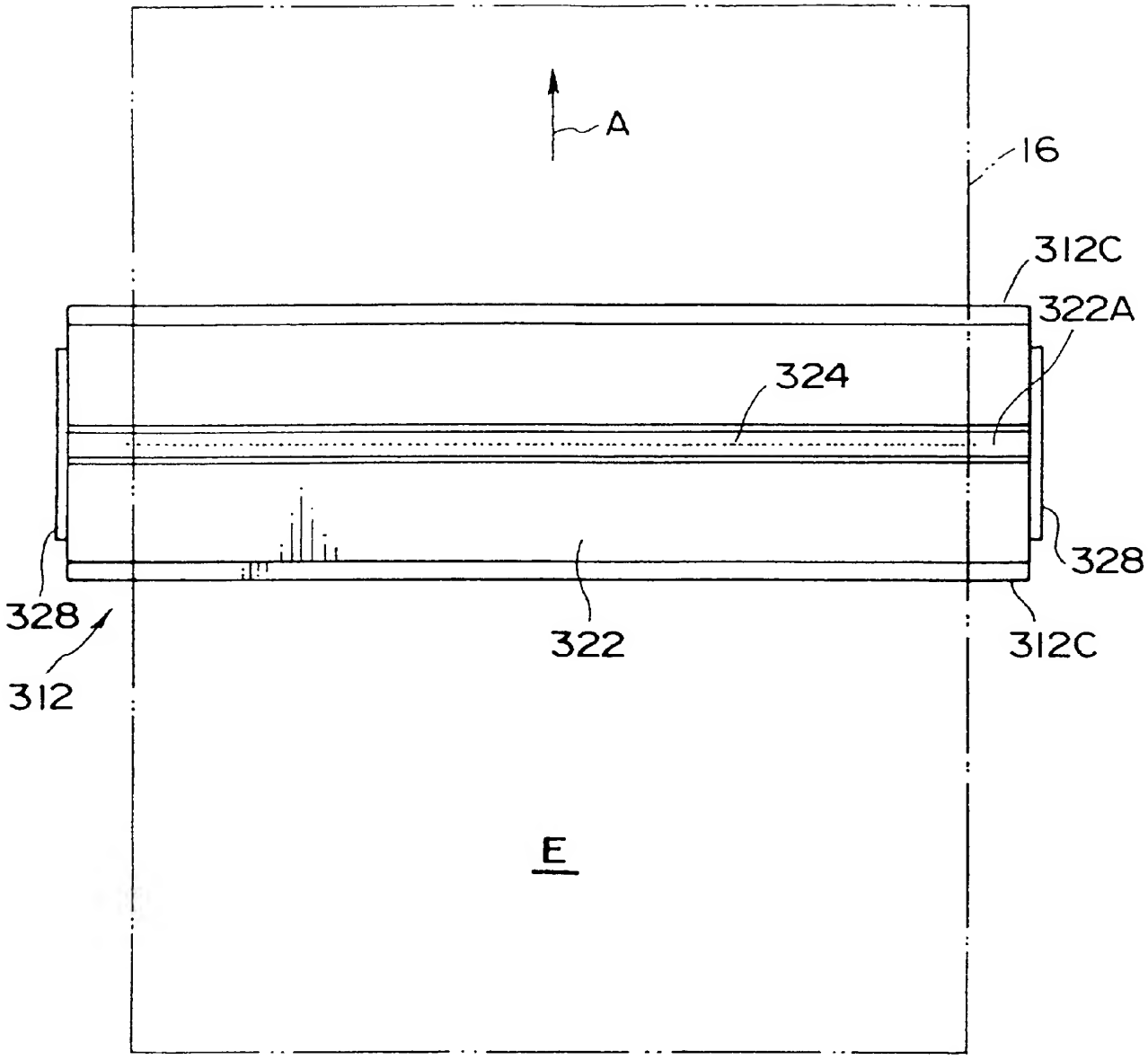


FIG. 5

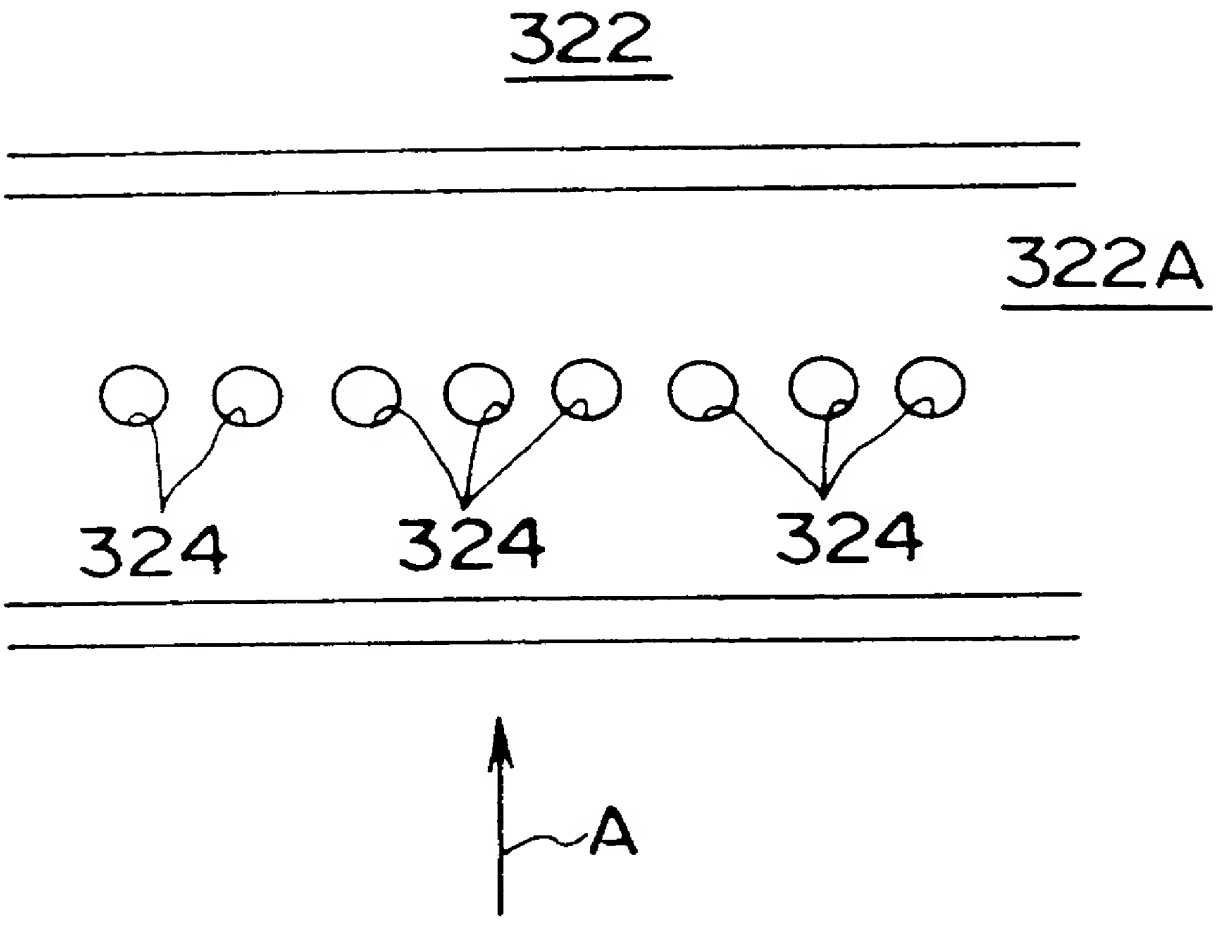
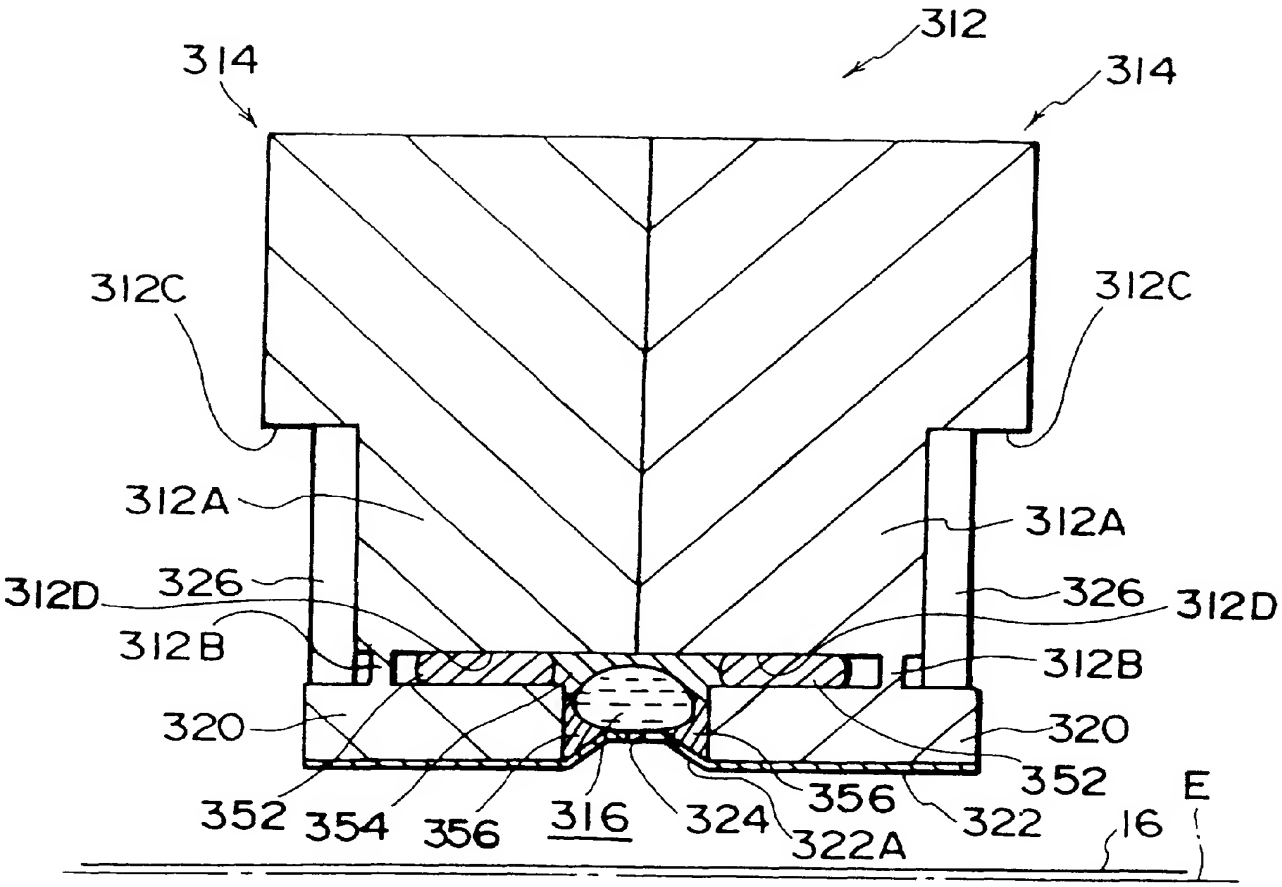


FIG. 6


312
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314
312C
312C
312A
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326
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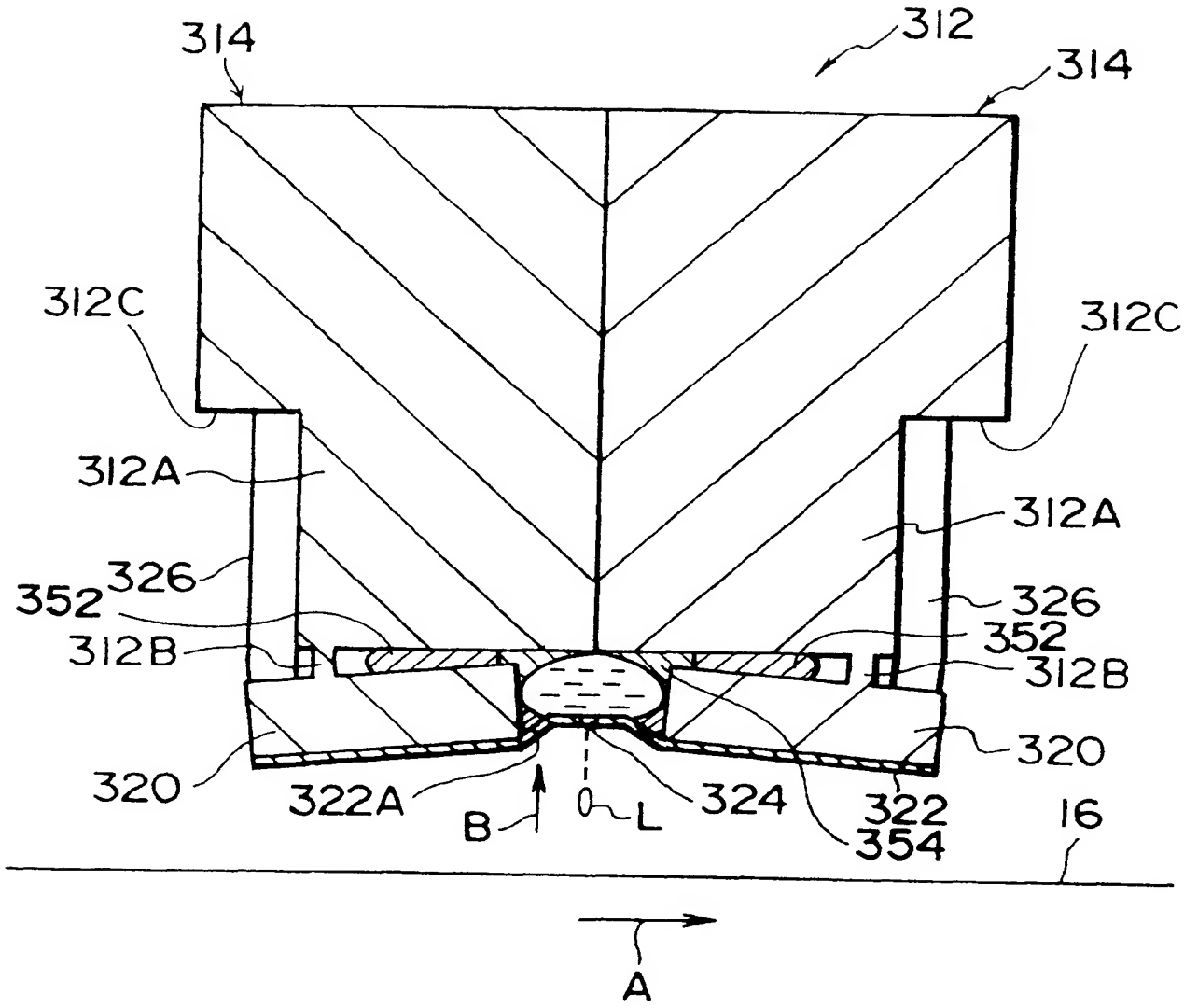
356
316
324
356
322
322A
16
E

FIG. 7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312C
312C
312A
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322A
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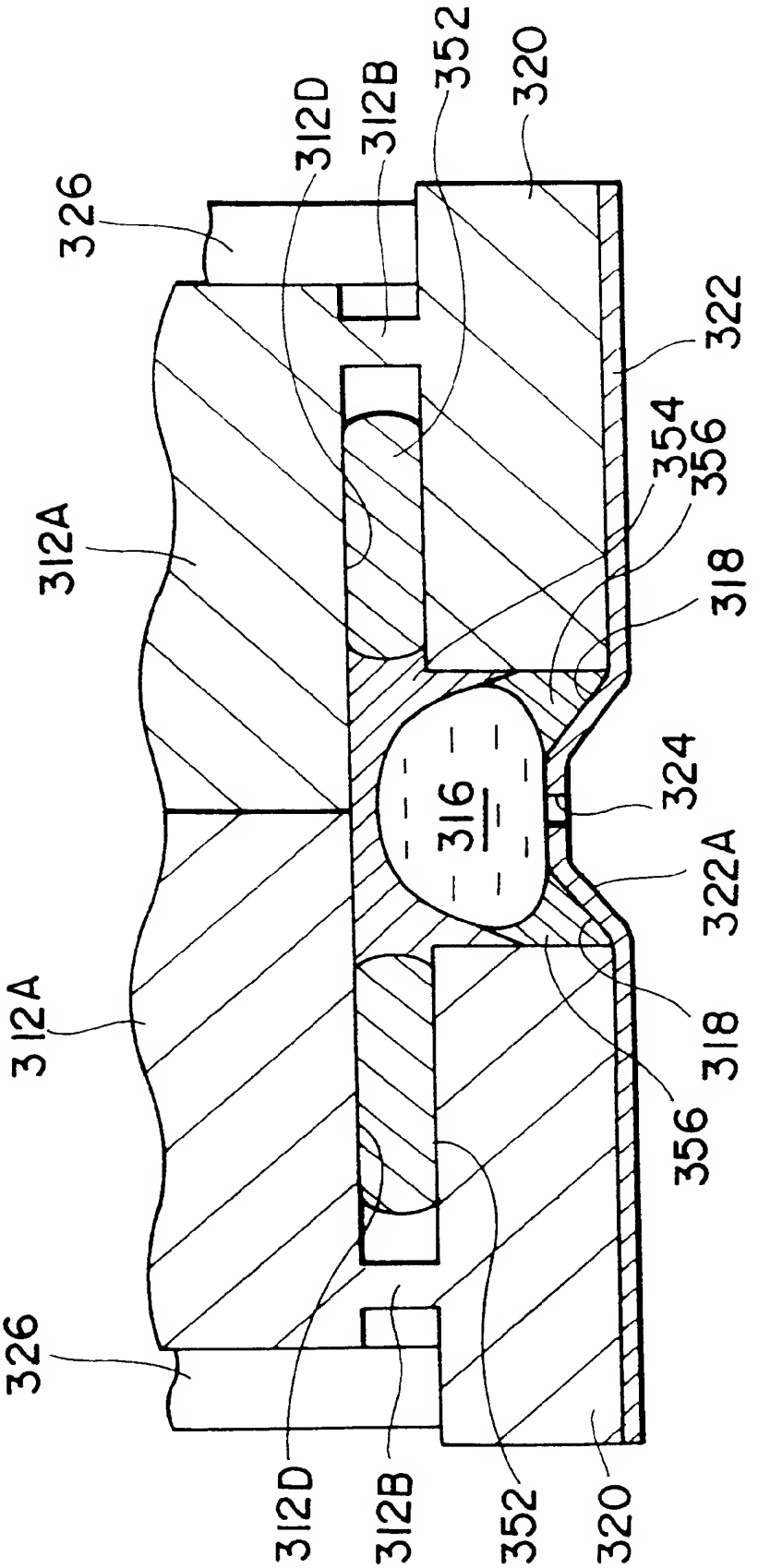
324
322
354
16
A

FIG. 8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312B
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322
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322A
312A
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312D
312B
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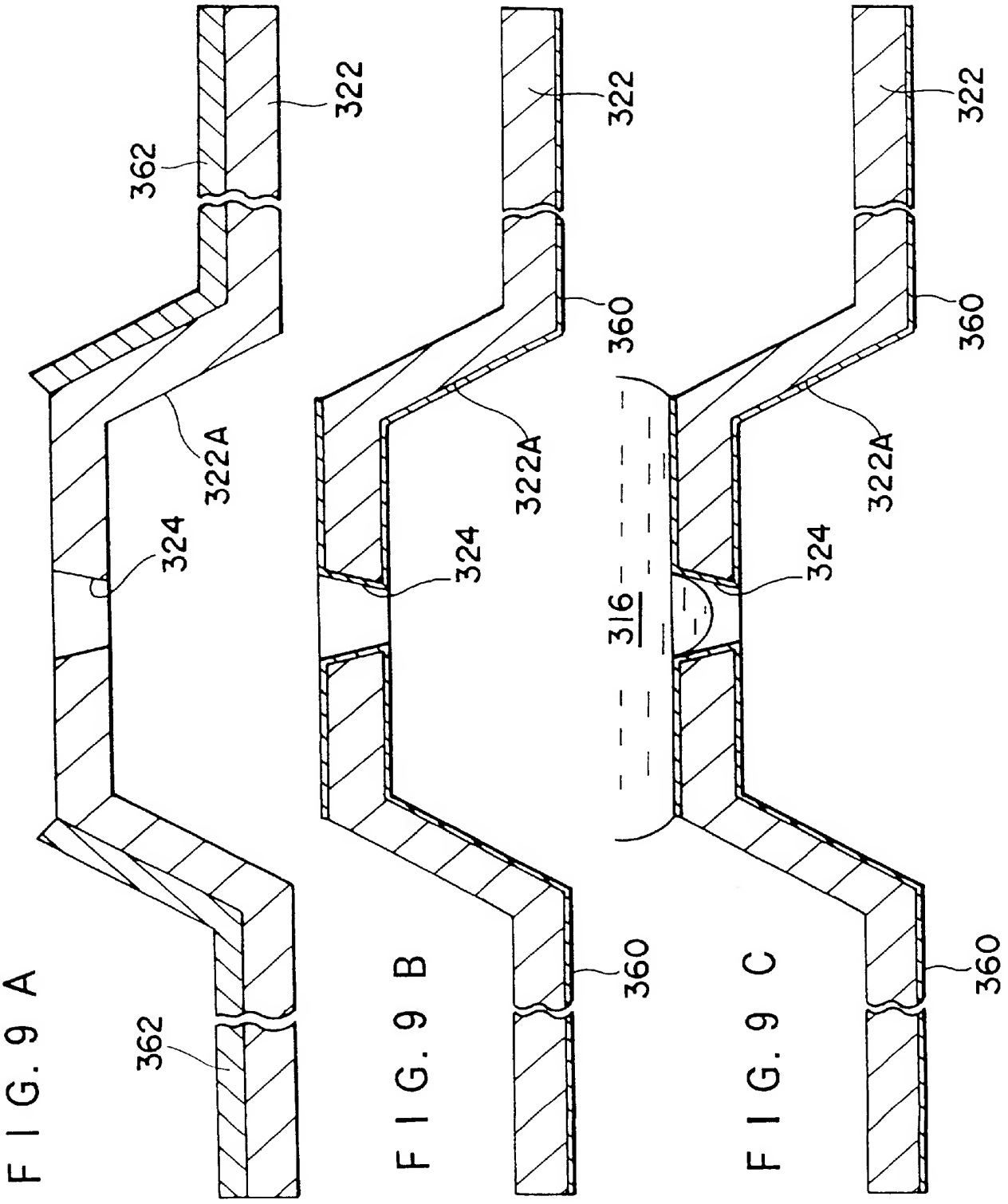
362
322
322A
324
362
FIG. 9 A
322
360
322A
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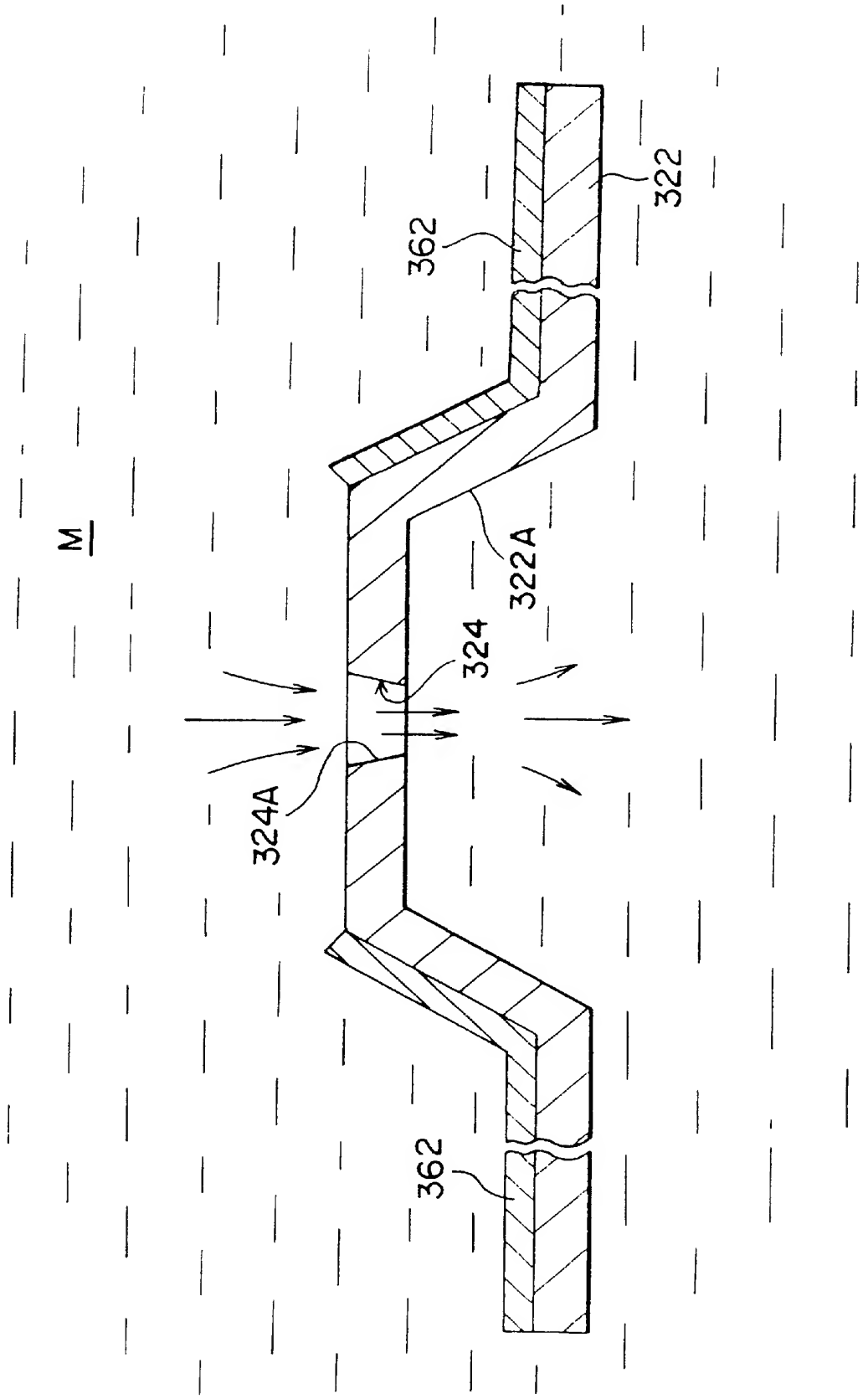
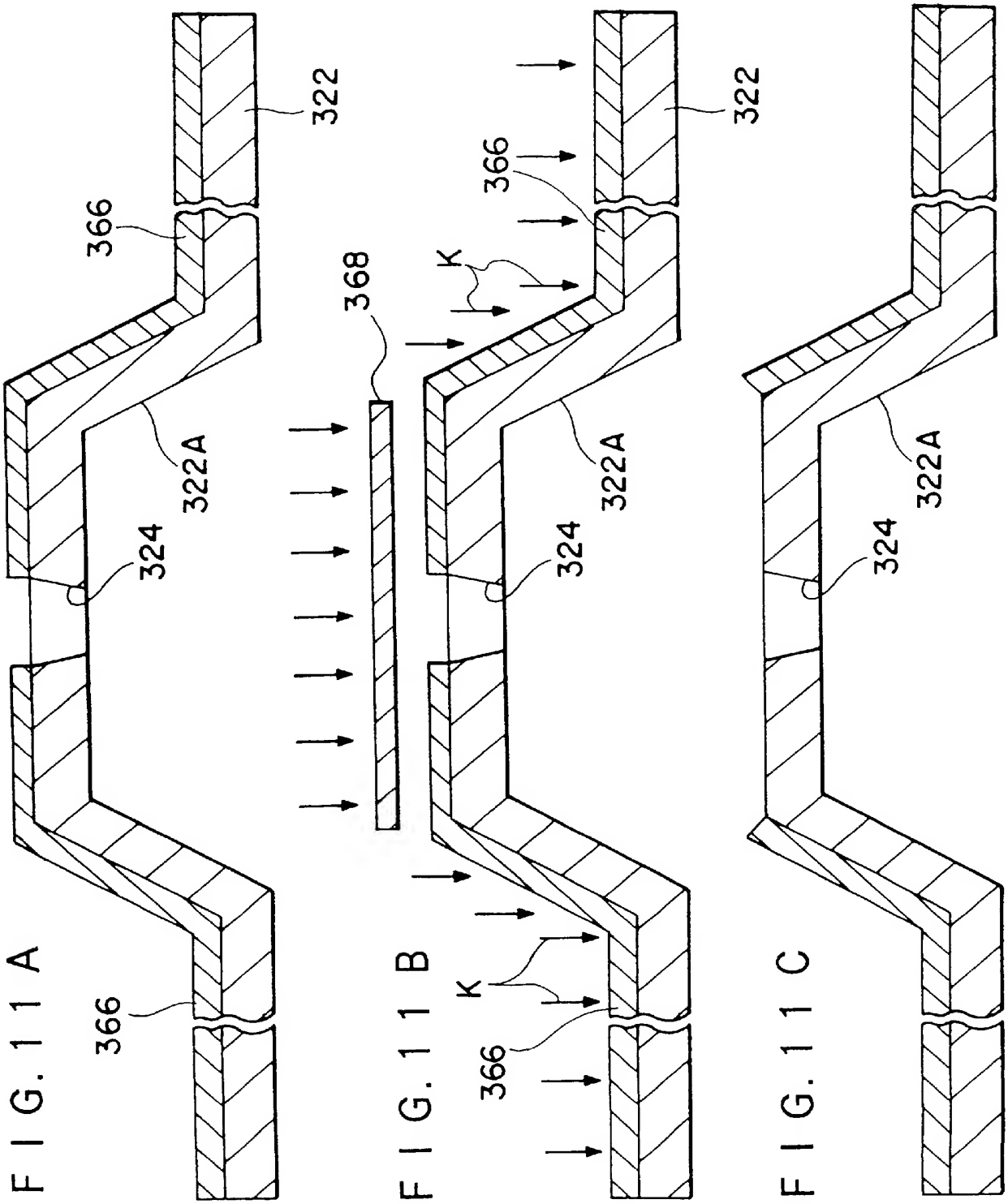
FIG. 9 B
322
360
322A
324
316
360
FIG. 9 C

FIG. 10




322
366
322A
324
366
FIG. 11A
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K
322A
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366
FIG. 11B
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322A
324
FIG. 11C

FIG. 12

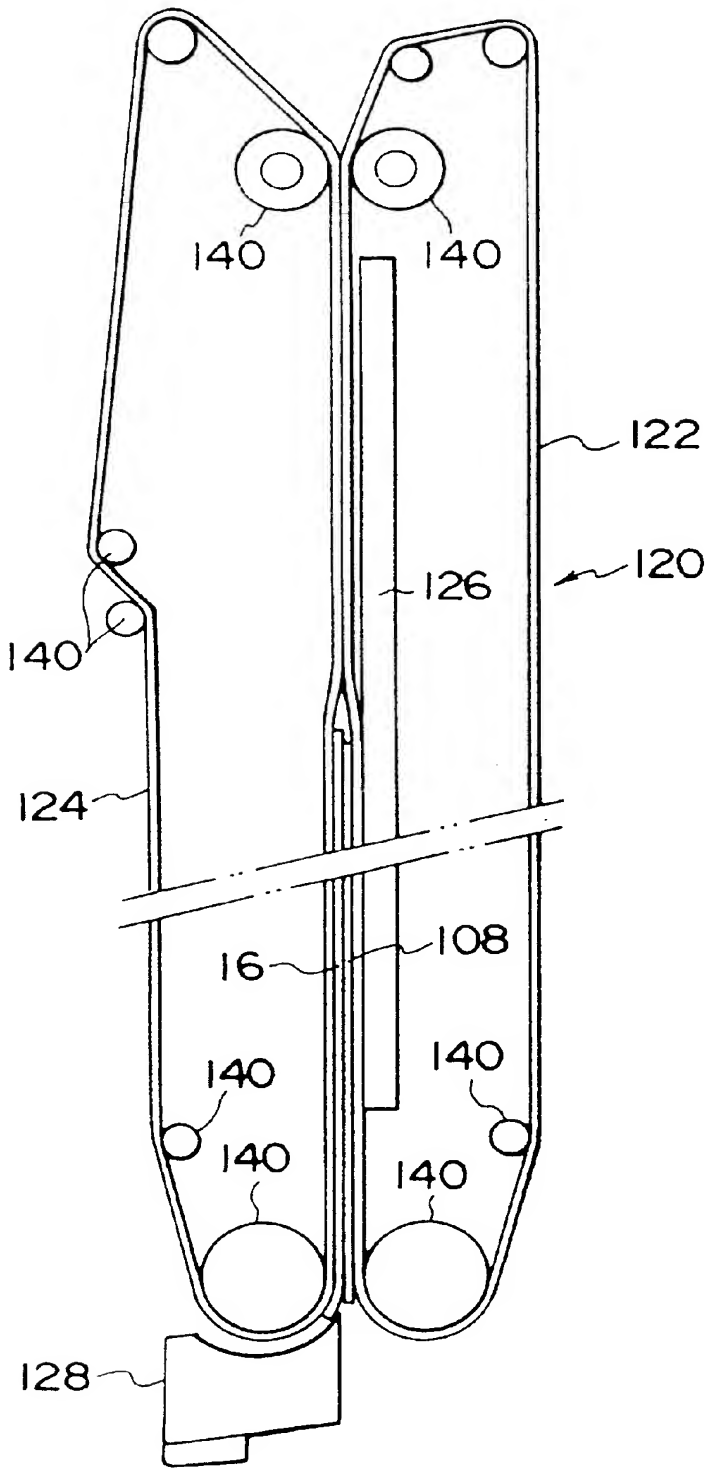
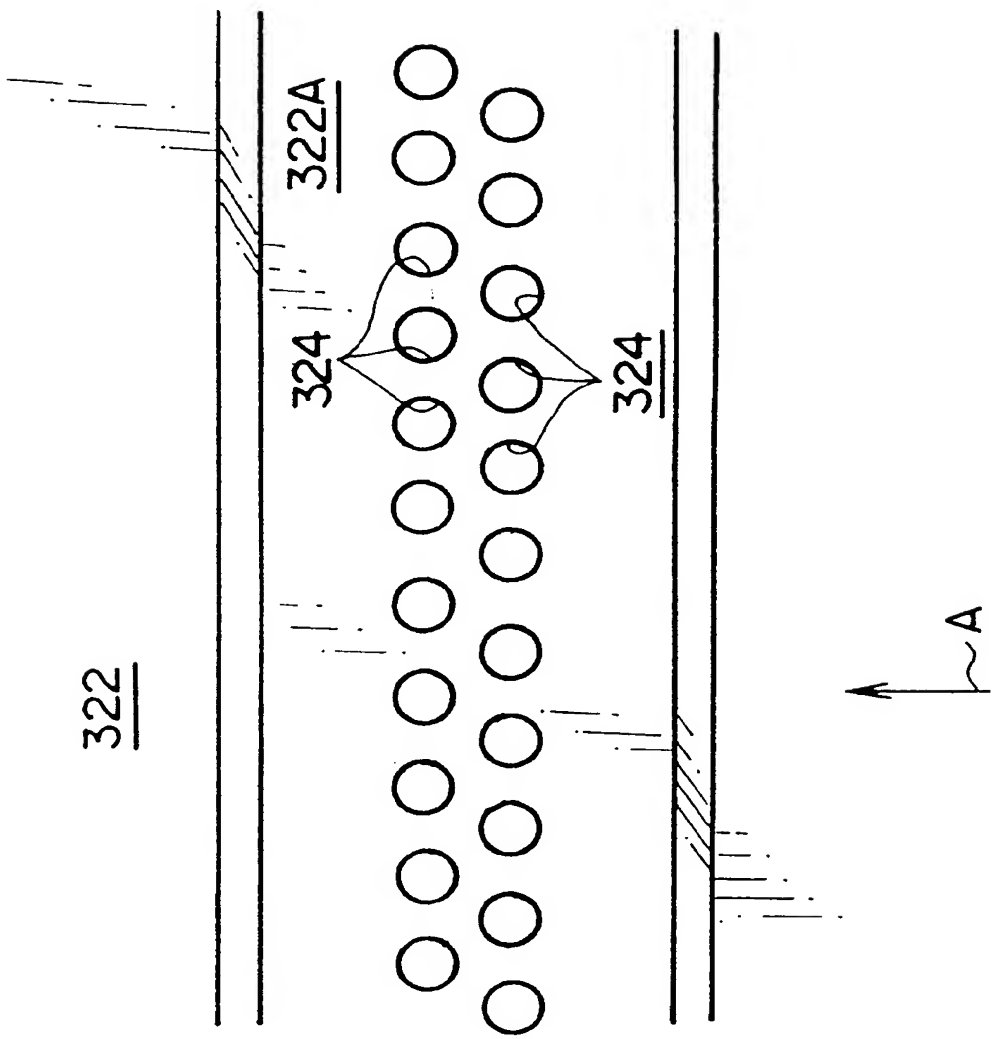


FIG. 13



LIQUID SPRAYING APPARATUS AND A METHOD OF MANUFACTURING THE LIQUID SPRAYING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid spraying apparatus which can spray an image forming solvent appropriately onto an image recording material such as a photosensitive material, an image recording material or the like, and to a method of manufacturing the liquid spraying apparatus.

2. Description of the Related Art

An image forming apparatus which effects an image recording process by using two types of image recording materials including, for example, a photosensitive material and an image receiving material has been known.

Inside this type of image forming apparatus, an image forming solvent application section having a tank for storing image forming solvent to apply to the photosensitive material is disposed. Further, a heat developing and transferring section comprising a heat drum and an endless press-contact belt, which is pressed into contact with the outer circumference of the heat drum and, rotated together with the heat drum.

The photosensitive material onto which an image is exposed, while being nipped and conveyed inside the image forming apparatus, is dipped into a tank storing therein water which is used as an image forming solvent at the image forming solvent application section. After water is applied to the photosensitive material, it is conveyed to the heat developing and transferring section. The image receiving material is also conveyed to the heat developing and transferring section, in the same manner as the photosensitive material.

In the heat developing and transferring section, the photosensitive material which has been subjected to water application is laminated with the image receiving material. In this laminated state, the photosensitive material is kept into close contact with the outer circumference of the heat drum and is rolled around the heat drum. Further, the photosensitive material and the image receiving material are nipped and conveyed between the heat drum and the endless press-contact belt. The photosensitive material is heat-developed and an image is transferred to the image receiving material, and a predetermined image is formed (recorded) on the image receiving material.

However, when the photosensitive material is dipped in a tank storing therein water as an image forming solvent and this water is applied to the photosensitive material, the water which has already been in contact with the photosensitive material consequently ends up remaining stored in the tank. As a result, bacteria breeds in the tank by taking organic material slightly eluted from the photosensitive material as a nutrient, and the water is thereby soiled. By this, the image forming apparatus itself and the image quality may be deteriorated.

Accordingly, a method in which the water supplying sides of a tank or the like and the photosensitive material do not come into contact with each other, and fine water droplets are sprayed from a sprayer and applied to the photosensitive material by vibrating a nozzle plate having a plurality of nozzle holes has been thought of.

However, at times when the sprayer is filled with water, such as when it is first used, the water pressure inside the sprayer may be in a higher positive pressure state than the outside air pressure. For this reason, since the nozzle holes which spray the water droplets cannot operate as valves to stem the flow of water, there is the concern that water may leak from the nozzle holes

SUMMARY OF THE INVENTION

In view of the aforementioned facts, it is an object of the present invention to provide a liquid spraying apparatus and a method of manufacturing the liquid spraying apparatus in which unnecessary leakage of an image forming solvent from the nozzle holes can be prevented.

In accordance with a first aspect of the present invention, there is provided a liquid spraying apparatus comprising a spray tank in which an image forming solvent is stored, a nozzle plate which is disposed on the spray tank as a portion of the wall surface of the spray tank and has a plurality of nozzle holes formed thereon for spraying the image forming solvent, and which can spray the image forming solvent from the plurality of nozzle holes in a reciprocating movement, and a water repelling layer which is provided at the internal periphery of the nozzle holes of the nozzle plate for repelling the image forming solvent.

In accordance with a second aspect of the present invention, there is provided a liquid spraying apparatus according to the first aspect of the present invention in which the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the external side of the spray tank.

In accordance with a third aspect of the present invention, there is provided a liquid spraying apparatus according to the second aspect of the present invention in which the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the internal side of the spray tank.

In accordance with a fourth aspect of the present invention, there is provided a liquid spraying apparatus comprising a spray tank in which an image forming solvent is stored, a nozzle plate which is provided on the spray tank as a portion of the wall surface of the spray tank and has a plurality of nozzle holes formed thereon for spraying the image forming solvent, and a water repelling layer which is provided at the internal periphery of the nozzle holes of the nozzle plate and repels the image forming solvent, and an actuator by which the nozzle plate is reciprocated.

In accordance with a fifth aspect of the present invention, there is provided a liquid spraying apparatus according to the fourth aspect of the present invention in which the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the external side of the spray tank.

In accordance with a sixth aspect of the present invention, there is provided a liquid spraying apparatus according to the fifth aspect of the present invention in which the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the internal side of the spray tank.

In accordance with a seventh aspect of the present invention, there is provided a method of manufacturing a liquid spraying apparatus in which a nozzle plate having a plurality of nozzle holes formed thereon for spraying an image forming solvent is provided as a portion of the wall surface of the spray tank comprising the steps of making a nozzle plate having a plurality of nozzle holes formed thereon, and providing a water repelling layer which repels an image forming solvent by flushing a plating liquid in circulation inside the nozzle holes of the nozzle plate, and effecting a plating process on the internal periphery of the nozzle holes.

The operation of the liquid spraying apparatus according to a first aspect of the present invention will now be explained.

An image forming solvent is stored in a spray tank. For example, the spray tank is disposed so as to oppose the conveying direction of an image recording material. A nozzle plate having a plurality of nozzle holes formed thereon for spraying the image forming solvent is provided on the spray tank as a portion of the wall surface thereof opposing the conveying direction of the image recording material. The image forming solvent is sprayed from the plurality of nozzle holes during a reciprocating movement of the nozzle plate. Further, a water repelling layer is provided at the internal periphery of the nozzle holes of the nozzle plate in order to repel the image forming solvent.

Accordingly, because a water repelling layer for repelling an image forming solvent is provided at the internal periphery of the nozzle holes of the nozzle plate which is provided as a portion of the wall surface of the spray tank, when the hydraulic pressure of the image forming solvent in the spray tank exhibits positive pressure, the nozzle hole can operate as a valve which repels and dams the image forming solvent. As a result, the image forming solvent is prevented from leaking unnecessarily from the nozzle holes.

The operation of the liquid spraying apparatus according to a second aspect of the present invention will be explained.

The present second aspect provides the same effect as the first aspect of the present invention. However, in accordance with the second aspect, because the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the external side of the spray tank, the peripheral portion of the nozzle holes can operate as a valve which can repel and dam the image forming solvent. As a result, the image forming solvent is prevented from leaking unnecessarily from the nozzle holes.

The operation of the liquid spraying apparatus according to a third aspect of the present invention will now be explained.

The third aspect provides the same effect as the second aspect of the present invention. However, in this aspect, because the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the internal side of the spray tank, in the same manner as the second aspect of the present invention, the peripheral portion of the nozzle hole operates as a valve which can repel and dam the image forming solvent. As a result, the image forming solvent is prevented from leaking unnecessarily from the nozzle holes.

The operation of a liquid spraying apparatus according to a fourth aspect of the present invention will now be explained.

The fourth aspect of the present invention provides the same effect as the third aspect of the present invention. However, in accordance with the present aspect, because the nozzle plate is reciprocated by an actuator along a conveying path in a direction so as to approach an image recording material, the image forming solvent stored inside the spray tank is sprayed from a plurality of nozzle holes, so as to accompany the actuator movement.

For this reason, when the actuator is not in use, in the same manner as the first aspect of the present invention, the nozzle holes can operate as valves, and the image forming solvent is prevented from leaking unnecessarily from the nozzle holes.

The operation of the liquid spraying apparatus according to a fifth aspect of the present invention will now be explained.

The fifth aspect provides the same effect as the fourth aspect of the present invention. However, in this aspect, because the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the external side of the spray tank, the periphery of a nozzle hole can operate as a valve which repels and dams an image forming solvent. As a result, the image forming solvent is prevented from leaking unnecessarily from the nozzle hole.

The operation of the liquid spraying apparatus according to a sixth aspect of the present invention will now be explained.

The sixth aspect provides the same effect as the fifth aspect of the present invention. However, in the present aspect, the water repelling layer is further provided on the periphery of the nozzle holes of the nozzle plate on the internal side of the spray tank. Accordingly, in the same manner as the fifth aspect of the present invention the periphery of a nozzle hole can operate as a valve which repels and dams an image forming solvent. As a result, the image forming solvent is prevented from leaking unnecessarily from the nozzle holes.

The operation of the method of manufacturing a liquid spraying apparatus according to a seventh aspect of the present invention will now be explained.

After a nozzle plate having a plurality of nozzle holes has been formed, the nozzle plate is plated in order to provide a water repelling layer which repels an image forming solvent at the nozzle plate. When this plating process is effected, a plating liquid is flushed into the nozzle holes and a plating layer is provided at the internal periphery of the nozzle holes.

Accordingly, because the plating liquid is flushed into the nozzle holes and circulated, a plating layer which forms the water repelling layer is formed on the internal wall surface of the nozzle holes more reliably and uniformly.

When the plating liquid is left in a nozzle hole without being flushed, new plating liquid does not reach the internal wall surfaces of the nozzle holes, and the formation of a plated layer on the internal wall surface of the nozzle holes becomes a matter of chance. Accordingly, the thickness of the water repelling layer which is formed on the internal wall surface of the nozzle holes is not even. However, in accordance with the present aspect, the water repelling layer can be formed in a more reliable and uniformed manner.

As a result, factors causing the water repelling state of the internal wall surfaces of the nozzle holes on which the plating process has been effected to vary can be eliminated, unnecessary leakage of an image forming solvent from the nozzle holes can be prevented, and the direction of dispersion of the water droplets can be made more stable at the time of atomization.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic overall view of an image recording apparatus according to an embodiment of the present invention.

FIG. **2** is a schematic overall view of an application apparatus according to an embodiment of the present invention.

FIG. **3** is an enlarged perspective view of a spray tank according to an embodiment of the present invention.

FIG. **4** is a bottom view of a state in which a photosensitive material is conveyed beneath the spray tank according to an embodiment of the present invention.

FIG. **5** is an enlarged view of a main portion in FIG. **4**.

FIG. **6** is a cross sectional view of the spray tank according to an embodiment of the present invention.

FIG. **7** is a cross sectional view of a state in which water is sprayed from the spray tank according to an embodiment of the present invention.

FIG. **8** is an enlarged cross sectional view of a main portion of the spray tank according to an embodiment of the present invention.

FIG. **9A** is a cross sectional view of a surface treatment of a nozzle plate according to an embodiment of the present invention and illustrates a state in which masking tape is attached to the nozzle plate.

FIG. **9B** is a cross sectional view of a surface treatment of the nozzle plate according to an embodiment of the present invention and illustrates a state in which a water repelling layer is provided on the nozzle plate.

FIG. **9C** is a cross sectional view of a surface treatment of the nozzle plate according to an embodiment of the present invention and illustrates the nozzle plate when it is in use.

FIG. **10** is a cross sectional view of a plating process of the nozzle plate according to an embodiment of the present invention.

FIG. **11A** is a cross sectional view of a surface treatment of the nozzle plate according to an embodiment of the present invention and illustrates a state in which a photoresist layer is formed.

FIG. **11B** is a cross sectional view of a surface treatment of the nozzle plate according to an embodiment of the present invention and illustrates a state in which it is exposed to the nozzle plate.

FIG. **11C** is a cross sectional view of a surface treatment of the nozzle plate according to an embodiment of the present invention and illustrates a state in which the masking has been completed.

FIG. **12** is an enlarged view of a heat developing and transferring section according to an embodiment of the present invention.

FIG. **13** is an enlarged view of a main portion illustrating the arrangement of nozzle holes in a spray tank according to a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows a schematic overall structural view of an image recording apparatus **10** serving as an image forming apparatus according to a first embodiment of the present invention.

As shown in FIG. **1**, a photosensitive material magazine **14**, which receives a photosensitive material **16** therein, is disposed in a housing **12** of the image recording apparatus **10**. This photosensitive material **16** is taken up around the photosensitive material magazine **14** in the form of a roll, and the photosensitive (exposure) surface of the photosensitive material **16**, which is pulled out from the photosensitive material magazine **14**, faces leftward.

Nip roller pairs **18** and a cutter **20** are provided near a photosensitive material output port in the photosensitive magazine **14**, and can cut the photosensitive material **16** which has been pulled out to a predetermined length. The cutter **20** is, for example, a rotary type of cutter formed of a moving blade and a stationary blade. The cutter **20** can cut the photosensitive material **16** by vertically moving the moving blade via a rotational cam or the like so as to mesh with the stationary blade.

A plurality of conveying roller pairs **24, 26, 28, 30, 32, 34** are sequentially provided on the downstream side of the cutter **20** in the direction in which the photosensitive material **16** is conveyed. A guide plate (not shown) is provided between each of the conveying roller pairs. The photosensitive material **16** cut to a predetermined length is conveyed firstly to an exposure section **22** provided between the conveying roller pairs **24** and **26**.

An exposure device **38** is provided at the left side of the exposure section **22**, and three types of LDs, a lens unit, a polygon mirror, and a mirror unit are disposed therein (none of them is shown). A light beam C is transmitted to the exposure section **22** from the exposure device **38** for the photosensitive material **16** to be exposed.

Further, above the exposure section **22**, provided are a U-turn portion **40** through which the photosensitive material is conveyed by being curved into a U-shape, and a water application section **50** which applies an image forming solvent to the photosensitive material **16**. In accordance with the present embodiment, water is used as an image forming solvent.

The photosensitive material **16**, which has come up from the photosensitive material magazine **14** and which has been exposed at the exposure section **22**, is nipped and conveyed by each of the conveying roller pairs **28** and **30**, and is fed to the water application portion **50** through the conveying path which is close to the upper portion of the U-turn portion **40**.

As shown in FIG. **2**, a spray tank **312** which forms a part of an application apparatus **310** serving as a liquid spraying apparatus is disposed at a position which is opposite to the conveying path E of the photosensitive material **16** inside the water application section **50**.

Further, as shown in FIG. **2**, a water bottle **332** for storing the water which is supplied into the spray tank **312** is disposed at the lower left side of the spray tank **312**, and a filter **334** for filtering the water is disposed at an upper portion of the water bottle **332**. A water supplying pipe **342**, which has a pump **336** disposed midway thereof, connects the water bottle **332** and the filter **334**.

Further, a sub-tank **338** for storing water which is supplied from the water bottle **332** is disposed at the right side of the spray tank **312**, and a water supplying pipe **344** extends from the filter **334** to the sub-tank **338**.

Therefore, when the pump **336** is operated, water is supplied from the water bottle **332** to the filter **334**, and the water, which has already passed through the filter **334** and been filtered, is supplied into the sub-tank **338** and is temporarily stored therein.

A water supplying pipe **346**, which connects the sub-tank **338** and a side end portion of the spray tank **312**, is disposed therebetween. The spray tank **312** is filled with water which has been pumped from the water bottle **332** by the pump **336**, through the filter **334**, the sub-tank **338**, the water supplying pipe **346**, and the like.

A tray **340**, which is connected to the water bottle **332** via a circulation pipe **348**, is disposed beneath the spray tank **312**. The tray **340** accumulates water overflowing the spray tank **312** and returns the water into the water bottle **332** via the circulation pipe **348**. Further, the circulation pipe **348** is connected to the sub-tank **338** in a state where the circulation pipe **348** projects and extends into the sub-tank **338**. The circulation pipe **348** returns the excessive water which has been accumulated in the sub-tank **338** into the water bottle **332**.

As shown in FIGS. **4** and **6**, a nozzle plate **322** made by an elastically deformable, rectangular, and thin plated plate

member (e.g., a thickness of 60 μm or less) is disposed, at a portion which opposes the conveying path E of the photosensitive material **16**, as a bottom wall surface forming a portion of the wall surface of this spray tank **312**. Further, in the present embodiment, the nozzle plate **322** uses a nickel plate made by electro-forging.

As shown in FIGS. **3** through **5**, a plurality of nozzle holes **324** (each of which has a diameter of 10 μm to 200 μm, for example) form a straight line on this nozzle plate **322** and are spaced apart from each other at a predetermined distance along a direction orthogonal to the conveying direction A of the photosensitive material **16**. A plurality of the nozzle holes **324** are disposed along the whole widthwise direction of the photosensitive material **16**. For this reason, water, with which the spray tank **312** has been filled, can be sprayed from the nozzle holes **324** on the side of the photosensitive material **16**.

In order to increase the rigidity of the nozzle plate **322** in the longitudinal direction thereof in which the nozzle holes **324** form a straight line, a concave portion **322**A extending in a direction in which the nozzle holes **324** form a straight line is bent.

As shown in FIGS. **2** and **3**, an exhaust pipe **330** extends from the upper portion of the spray tank **312** on the opposite side to the portion where the water supplying pipe **346** is connected. The exhaust pipe **330** connects the outside and inside portions of the spray tank **312**. A valve (not shown) for opening or closing this exhaust pipe **330** is provided midway on the exhaust pipe **330**, and the spray tank **312** can be opened or closed to the outside air by the opening or closing movement of this valve.

Both end portions of the nozzle plate **322**, being the end portions of the nozzle plate which is positioned in an orthogonal direction with respect to the direction of the row of nozzles made up of the plurality of nozzle holes **324** arranged in a line, are bonded with an adhesive or the like respectively to a pair of lever plates **320**, which serve as displacement transmitting members, as is shown in FIG. **6**. Through this adhesive bonding, the nozzle plate **322** and a pair of the lever plates **320** are connected to each other. The pair of the lever plates **320** are respectively fixed to a pair of tank body structural members **312**A via supporting portions **312**B. Each of the supporting portions **312**B has a narrow width and extends along a direction in which a plurality of the nozzle holes **324** form a straight line, and is provided at the lower wall portion of each of the tank body structural members **312**A of the spray tank **312**.

The pair of tank body structural members **312**A have smooth facing surfaces which are abutted with no gap therebetween, and form an upper side portion of the spray tank **312**. Further, step portions **312**C protruding by a step from the spray tank **312** are provided on the pair of tank body structural members **312**A, respectively. The spray tank **312** is formed into a configuration where the portions, above the midpoint of the spray tank **312** in a vertical direction, protrude.

A plurality of piezoelectric elements **326** serving as actuators (in this embodiment, three piezoelectric elements are provided on each side) are adhered to the lower side surfaces of the step portions **312**C. The external end portions of each of the lever plates **320**, being the portions of the lever plates **320** which are positioned on either side of the supporting members **312**B with respect to the plurality of nozzle holes **324**, are adhered to the lower surfaces of the piezoelectric elements **326**. Accordingly, the piezoelectric elements **326** and the lever plates **320** are connected to each other.

As a result, a lever mechanism is formed by the piezoelectric elements **326**, the lever plates **320**, and the supporting portions **312**B. Accordingly, a pair of recessed portions **312**D inside which the lever plates **320** can swing are respectively provided between the pair of lever plates **320** and the pair of tank body structural members **312**A. Each of the recessed portions **312**D is filled with an elastic member **352** (for example, a silicon adhesive) formed from silicon rubber.

As described above, when the external end side portions of each of the lever plates **320** are moved by the piezoelectric elements **326**, the lever plates **320** swing around each of the supporting portions **312**B, while the internal end side portions of each of the lever plates **320** move in a reverse direction to the external end side portions of the lever plate **320**. At this time, the elastic members **352** may be compressed or stretched in accordance with a swinging movement of the lever plate **320**. However, they should not hinder the swinging of the elastically deformed lever plate **320**.

The piezoelectric element **326** is made by, for example, laminated piezoelectric ceramics. Accordingly, the displacement in an axial direction of the piezoelectric element **326** is made large, and this piezoelectric element **326** is connected to a power source (not shown) through which the timing of voltage application can be controlled by a controller. The aforementioned valve for opening/closing the exhaust pipe **330** is also connected to this controller which then controls the opening/closing of the valve.

The lever plates **320**, the tank body structural members **312**A, and the supporting members **312**B each form portions of the integrally formed frame **314**. As shown in FIG. **6**, the pair of frames **314** are fitted to each other and screwed together by bolts (not shown). Accordingly, the outer frame of the spray tank **312** is formed in a state in which the pair of lever plates **320**, the pair of tank body structural members **312**A, and the pair of supporting members **312**B face each other, respectively. Further, the frame **314** is formed by an extrusion material molded through aluminum extrusion molding.

FIG. **8** is an enlarged view illustrating the main portion of the spray tank **312**. As shown in this figure, in the spray tank **312**, a space is formed between the tip end portions of a pair of the lever plates **320**. This space has a substantially rectangular cross section, and is demarcated by the bottom surfaces of the pair of tank body structural members **312**A, the tip end portions of the pair of lever plates **320**, and the upper surface of the nozzle plate **322**. A solvent storing space **316** is formed within the space and stores water therein.

This substantially rectangular space is filled with an elastic member **354** (silicon adhesive) made from silicone rubber so that a smooth free curve without concave or convex portions is created, and forms the internal wall surface of the solvent storing space **316**. The sealing ability can be maintained on the periphery of the recessed portions **312**D by this elastic member **354**.

A pair of concave portions **318** is formed on a recessed portion **322**A on the nozzle plate **322**, each of which forms a part of the solvent storing space **316**, between the upwardly protruding portions of the recessed portion **322**A in FIG. **8** and the tip end surfaces of a pair of the lever plates **320**.

Because the concave portions **318** are filled so that the surface bulges out slightly with surface-bonding adhesives **356** (e.g., thermoplastic seat adhesives), the lever plate **320** and the nozzle plate **322** are joined without any gaps. The

internal wall surface of the solvent storing space **316** for storing water, is formed from the smooth curved surfaces of the surface-bonding adhesives **356** and the elastic member **354**.

Namely, a filling material is formed by the elastic members **352** and **354** which can deform elastically and the surface-bonding adhesives **356**, and the recessed portions **312**D and the solvent storing space **316** are filled with an elastic material and a plastic material. Since the cross sectional configuration of the solvent storing space **316**, which is shown in FIG. **6** and stores water from the spray tank **312**, is similar to a smoothly curved circular pipe shape, it is difficult for air bubbles to be deposited on the internal portions of the spray tank **312**.

As shown in FIG. **9**C, a water repelling layer **360** for repelling water is provided on the top and rear surfaces of the nozzle plate **322** at the peripheral portion of the nozzle holes **324**, which includes the internal portion of the nozzle holes **324**.

The water repelling layer **360** is made by co-precipitating nickel-phosphorus and PTFE (polytetrafluoroethylene resin) so as to have a thickness of, for example, 3 to 5 μm. Accordingly, the top and rear surfaces of the nozzle plate **322** at the peripheral portion of the nozzle holes **324** and the internal peripheral surfaces of the nozzle holes **324** are made water repellent by a polytetrafluoroethylene resin. For this reason, even when the water inside the solvent storing space **316** of the spray tank **312** has a positive pressure, for example, each of the nozzle holes **324** operates as a valve in order to dam the water.

Next, a process in which the water repelling layer **360** is adhered to the nozzle plate **322** is explained.

The thin-plate nozzle plate **322** is made by nickel electroforging. At this time, a plurality of extra fine nozzle holes **324** are pre-formed on the nozzle plate **322**.

Next, as shown in FIG. **9**A, in order to obtain an adhesive surface of the nozzle plate **322** which adheres to each of the lever plates **320**, masking tape **362** which is heat and chemical resistant is attached to the respective end portions of the nozzle plate **322** on the side to be adhered to each of the lever plates **320**. Thereafter, a plating process is effected.

In the plating process, an alcohol degreasing process, an acid washing process, and an alkali washing process are carried out sequentially. Thereafter, a co-precipitating plating process is effected in order to co-precipitate nickel-phosphorus and PTFE (polytetrafluoroethylene resin). As a result, a water repelling layer **360** being a plating layer is formed on the nozzle plate **322** except for the portions where the masking tape **362** has been attached.

Thereafter, a mask melting process is effected in order to detach the masking tape **362**, and, after being in the state which is shown in FIG. **9**, the nozzle plate **322** finally undergoes a heat processing in which the water repelling layer **360** is provided on the periphery of the nozzle holes **324**, completing the formation of the nozzle plate **322**.

An ordinary electroless plating process is employed to effect this plating process. However, in this plating process, a plating liquid M is stirred, and as shown in FIG. **10**, the plating liquid M is flushed into the nozzle holes **324** inside the plating process tank, and the plating liquid M is circulated inside the nozzle holes **324**. As a result, fresh plating liquid M reaches the internal wall surface **324**A of the nozzle holes **324**, and the water repelling layer **360** which has been plated and which is deposited on the internal wall surfaces **324**A of the nozzle holes **324** can be formed so as to have an uniform thickness.

The water repelling layer **360** having a thickness of less than or equal to 5 μm can be applied to the top and rear surfaces of the nozzle plate **322**, and the water repelling layer **360** having a thickness which is substantially the same as the aforementioned can be applied stably and uniformly to the internal wall surface **324**A of the nozzle holes **324**.

As a result, factors causing the water repelling state of the internal wall surfaces of the nozzle holes **324** on which a plating process has been effected to vary can be eliminated, unnecessary leakage of water from the nozzle holes **324** can be prevented, and the direction of dispersion of the water droplets L can be made more stable, at the time of atomization of water.

Because the plating process tank is equipped with a strainer (not shown), dust can be removed, and deposition of dust into the nozzle holes **324** can be prevented during the plating process. Accordingly, the direction of dispersion of the water droplets L can be made more stable. A small amount of the plating liquid M is sufficient for circulating providing that the plating liquid M can be supplied into the nozzle holes **324**.

As shown in FIG. **11**A, separate to this, a layer of photoresist **366** is formed on the whole surface of the nozzle plate **322** on the surface of the side to be adhered to the lever plates **320**. As shown in FIG. **11**B, the nozzle plate **322** is exposed thereon, so that the surface of the nozzle plate **322**, excepting the peripheral portions of the nozzle holes **324**, is irradiated by the exposing light rays K. Further, as shown in FIG. **11**C, masking can be effected on the nozzle plate **322** by eliminating unexposed portions of photoresist **366** by using a solvent. Thereafter, a plating process is effected in the same manner as described above.

As described above, since piezoelectric elements **326** are disposed in the spray tank **312**, the nozzle plate **322** can oscillate uniformly and to a large degree along the direction in which the plurality of nozzle holes **324** form a straight line. For this reason, a vibration amplitude distributed uniformly along a widthwise direction of the photosensitive material **16**, at which the water pressure at the peripheral portions of the nozzle holes **324** can be a pressure at which water can be atomized, can be provided. As a result, water can be sprayed and atomized substantially evenly from the plurality of nozzle holes **324** along the entire widthwise direction portion of the photosensitive layer **16**.

As shown in FIGS. **3** and **4**, at the portions which are demarcated by the longitudinal ends of the nozzle plate **322**, being the end portions of the nozzle plate **322** which is positioned in the lengthswise direction of the row of nozzles formed by the nozzle holes **324**, and the end portions of the pair of frames **314**, thin sealing plates **328** are disposed in a state in which the thin sealing plates **328** are adhered to the pair of frames **314**.

In order to fill the gap formed by the longitudinal ends of the nozzle plate **322**, the end portions of the pair of frames **314**, and the pair of sealing plates **328**, and to prevent water from leaking from the aforementioned gap, the internal sides of sealing plates **328** are filled with an elastic adhesive such as a silicone rubber adhesive. Accordingly, the gaps within the spray tank **312** can be sealed with an elastic adhesive without hindering the movement of the longitudinal ends of the nozzle plate **322**. Moreover, the longitudinal ends of the spray tank **312** may be sealed by an elastic adhesive only, without using the pair of in sealing plates **328**.

As described above, when the piezoelectric elements **326** are energized, as shown in FIG. **7**, each of the piezoelectric elements **326** is extended so that each of the lever plates **320**

is rotated axially around the respective supporting portions **312**B. By this movement, the piezoelectric element **326** deforms and displaces the nozzle plate **322** via the lever plate **320** so as to move the central portion of the nozzle plate **322** upwards in the direction of arrow B. In accordance with the deformation of the nozzle plate **322**, the water pressure in the spray tank **312** increases, and water droplets L, i.e., small amounts of water are sprayed collectively and linearly from each of the nozzle holes **324**.

Further, water droplets L can be continuously sprayed from the nozzle holes **324** by repeating the energizing and extending of the piezoelectric elements **326**.

As shown in FIG. **1**, the image receiving material magazine **106** which receives the image receiving material **108** is disposed at the upper left end portion of the housing **12**. A dye fixing material having a mordant is applied on the image forming surface of the image receiving material **108**. The image receiving material **108** which has been pulled out from the image receiving material magazine **106** is rolled around the image receiving material magazine **106** so that the image forming surface of the image receiving material faces downwards.

In the vicinity of the image receiving material output portion of the image receiving material magazine **106**, a pair of nip rollers **110** is provided. The nip rollers **110** nip the image receiving material **108** and pull out the image receiving material **108** from the image receiving material magazine **106**, and cancel the nipping.

A cutter **112** is disposed at the side of the nip rollers **110**. The cutter **112** is substantially the same as the cutter **112** for the photosensitive material as described above, for example, being formed by a stationary blade and a moving blade. For this reason, by moving the moving blade of the cutter **112** vertically by a rotation cam or the like, so that it meshes with the stationary blade of the cutter **112**, the image receiving material **108** which has been pulled out from the image receiving material magazine **106** can be cut to a length which is shorter than the photosensitive material **16**.

Conveying roller pairs **132**, **134**, **136**, **138** and a guide plate (not shown) are disposed at the side of the cutter **112**, and can convey to the heat developing and transferring section **120** the image receiving material **108** which has been cut to a predetermined length.

As shown in FIGS. **1** and **12**, the heat developing and transferring section **120** is wound around a plurality of pairs of winding rollers **140**, respectively, and has a pair of the endless belts **122** and **124**. Each of the endless belts **122** and **124** is formed in a looped shape whose vertical direction is a longitudinal direction. Accordingly, when one of the pairs of winding rollers **140** is driven and rotated, the pair of endless belts **122** and **124** which are wound around the winding rollers **140** are rotated, respectively.

In a loop of the endless belt **122** (at the upper right side in FIGS. **1** and **12**) of the pair of endless belts **122** and **124**, a heating plate **126** is formed in a plate shape whose vertical direction is a longitudinal direction. The heating plate **126** is disposed so as to face the internal left side peripheral portion of the endless belt **122**. An unillustrated linear heater is provided in the internal portion of the heat plate **126**. The surface temperature of the heating plate **126** is raised by this heater. As a result, the surface of the heating plate **126** can be maintained at a predetermined temperature.

Accordingly, the photosensitive material **16** is conveyed by the pair of conveying rollers **34** into the pair of endless belts **122** and **124** at the heat developing and transferring section **120** at the end of the conveying path. Further, the conveyance of the image receiving material **108** is synchronized with the conveyance of the photosensitive material **16**. In a state in which the photosensitive material **16** is conveyed prior to the image receiving material **108** by a predetermined length, the image receiving material **108** is conveyed by a pair of conveying rollers **138** at the end of the conveying path into the pair of endless belts **122** and **124** at the heat developing and transferring section **120**, and is laminated with the photosensitive material **16**.

In this case, the image receiving material **108** has widthwise and lengthwise dimensions which are smaller than those of the photosensitive material **16**. Accordingly, when the photosensitive material **16** is laminated with the image receiving material **108**, the four sides of the periphery of the photosensitive material **16** project from those of the periphery of the image receiving material **108**.

As described above, the photosensitive material **16** and the image receiving material **108** which have been laminated to each other by the pair of endless belts **122** and **124** are nipped and conveyed by the endless belts **122** and **124** in a laminated state. When the laminated photosensitive material **16** and the image receiving material **108** have been completely entered into the endless belts **122** and **124**, the pair of endless belts **122** and **124** stops rotating temporarily and the nipped photosensitive material **16** and image receiving material **108** are heated by the heating plate **126**. During the time at which the photosensitive material **16** is nipped and conveyed, and is stopped, it is being heated through the endless belt **122** and the heating plate **126**. Together with the heating, the photosensitive material **16** discharges a movable dye. At the same time, the dye is transferred to a dye fixing layer of the image receiving material **108**, and an image is formed on the image receiving material **108**.

On the downstream side in the direction the material is fed, of the pair of endless belts **122** and **124**, a peel-off pawl **128** is disposed. For this reason, the peel-off pawl **128** can engage the front edge portion of the photosensitive material **16** only out of the photosensitive material **16** and the image receiving material **108** which are nipped and conveyed between the pair of endless belts **122** and **124**, and peels the front edge portion of the photosensitive material **16**, which protrudes from between the pair of endless belts **122** and **124**, from the image receiving material **108**.

At the left side of the peel-off pawl **128**, photosensitive material discharging rollers **148** are disposed. The photosensitive material **16** is moved to the left by being guided by the peel-off pawl **128**, and can be conveyed to the side of a discharged photosensitive material accommodating section **150**.

The discharged photosensitive material accommodating section **150** has a drum **152** around which the photosensitive material **16** is rolled, and has a belt **154**, a portion of which is rolled around the drum **152**. The belt **154** is rolled around a plurality of rollers **156**, and moves through the rotation of the rollers **156**. In accordance with this, the drum **152** can rotate.

Therefore, in a state in which the belt **154** is conveyed due to the rotation of the rollers **156**, when the photosensitive material **16** is fed into the rollers **156**, the photosensitive material **16** can be collected around the drum **152**.

In FIG. **1**, receiving material discharge rollers **162**, **164**, **166**, **168**, **170** are sequentially disposed in order to convey the image receiving material **108** from the bottom of the pair of endless belts **122** and **124** to the left. For this reason, the image receiving material **108** which has been discharged from the pair of endless belts **122** and **124** is conveyed by the

receiving material discharging rollers **162**, **164**, **166**, **168**, **170**, and discharged into a tray **172**.

Next, operation of a first embodiment of the present invention will be explained.

In the image recording device **10** which is structured as described above, after the photosensitive material magazine **14** has been set, nip rollers **18** are operated and the photosensitive material **16** is pulled out by the pair of nip rollers **18**. When a predetermined length of the photosensitive material **16** is pulled out, the cutter **20** is operated and the photosensitive material **16** is cut to a predetermined length and conveyed to the exposure section **22** in a state in which the photosensitive (exposure) surface is facing to the left. The exposure device **38** is operated while the photosensitive material **16** passes through the exposure section **22**, and an image is scanned and exposed to the photosensitive material **16** which is positioned at the exposure section **22**.

When the exposure has been completed, the exposed photosensitive material **16** is forwarded to the water application section **50**. In the water application section **50**, the conveyed photosensitive material **16** is fed to the side of the spray tank **312** through the driving of the conveying rollers **32** as shown in FIG. **4**.

The movement and operation of the photosensitive material **16** during which the photosensitive material **16** which is conveyed along the conveying path E is deposited with water from the spray tank **312** will now be explained.

The spray tank **312** storing water therein is provided at the upper portion of the conveying path E so as to face the conveying path E of the photosensitive material **16**. The nozzle plate **322** in which the plurality of nozzle holes **324** for spraying form a straight line is provided as the bottom wall surface of the spray tank **312** facing the conveying path E of the photosensitive material **16**.

Further, a pair of elongated lever plates **320** are respectively connected to portions at the end sides of the nozzle plate **322** in a direction orthogonal to the direction in which the plurality of nozzle holes **324** form a straight line. The pair of lever plates **320** are supported so as to be able to swing around a pair of supporting portions **312**B extending along a direction in which a plurality of the nozzle holes **324** form a line.

When water is sprayed from the spray tank **312**, a pump **336** is operated and the spray tank **312** is filled with water fed from the water bottle **332** through a filter **334**, a sub tank **338**, a water supplying pipe **346** or the like. Thus, the spray tank **312** is filled with water which is stored therein. Thereafter, the controller closes the valve of the discharging tube **330**.

When the spray tank **312** is filled with water, the water pressure may vary, and the water pressure within the spray tank **312** may be a higher positive pressure than the outside air pressure. However, the water repelling layer **360** for repelling water is provided on the nozzle plate **322** including the internal portions of the nozzle holes **324**, and the peripheral portions of the nozzle holes **324**. A description thereof will now be given.

Namely, the nozzle plate **322** forms a portion of the wall surface of the solvent storing space **316** in the spray tank **312**. The water repelling layer **360** for repelling water is provided on the periphery of the nozzle holes **324** of the nozzle plate **322**. Accordingly, even if the water pressure within the spray tank **312** is in a positive pressure, the water repelling layer **360** on the periphery of the nozzle holes **324** repels water and serves as a valve which dams the water. As a result, water is prevented from leaking from the spray tank **312**.

When the water is atomized and sprayed, a voltage is applied to the piezoelectric elements **326** through a power source controlled by a controller in order to elongate all of the piezoelectric elements **326** simultaneously.

When the plurality of piezoelectric elements **326** expand so as to all be extended at the same time, the pair of lever plates **320** are swung around the respective supporting portions **312**B, and the portion of the nozzle plate **322** surrounding the nozzle holes **324** is reciprocated above the conveying path E in a direction facing the photosensitive material **16**, (in this case, the portion of the nozzle plate **322** moves in the direction of arrow B in FIG. **7**), and the nozzle plate **322** pressurizes the water within the solvent storing space **316** of the spray tank **312**.

As described above, together with the movement of the piezoelectric elements **326**, the water with which the solvent storing space **316** is filled, is sprayed from the plurality of nozzle holes **324**. As a result, as shown in FIG. **7**, the water with which the spray tank **312** has been filled, is sprayed and atomized from the nozzle holes **324** and can be deposited on the photosensitive material **16** during the conveyance thereof.

As a result, water can be uniformly applied to the top surface of the photosensitive material **16** by the spray tank **312** which does not contact the photosensitive material **16**.

Together with the movement of the piezoelectric elements **326**, the lever plates **320** swing around their respective supporting portions **312**B which extend in the direction in which the plurality of nozzle holes **324** form a straight line. Accordingly, the whole portion of the nozzle plate **322** having the plurality of nozzle holes **324** displaces uniformly.

For this reason, along the longitudinal direction in which a plurality of the nozzle holes **324** form a straight line, all the nozzle holes **324** can be displaced by the same, stably fixed displacement amount, and the water, with which the spray tank **312** has been filled, is sprayed evenly from the plurality of nozzle holes **324**. Therefore, it is difficult for areas of the photosensitive material **16** to remain untouched by water.

The spray tank **312** has the nozzle holes **324** and water is sprayed from the nozzle holes **324**. Accordingly, as compared to application devices in which a photosensitive material or the like is dipped in a tank storing water therein and water is applied thereto, a smaller amount of water is enough for the application of the photosensitive material **16**, and the photosensitive material **16** can dry in a shorter period of time.

The spray tank **312** has a plurality of the nozzle holes **324** which are disposed across the entire widthwise direction of the photosensitive material **16**. Through one displacement of the plurality of nozzle holes **324** by the piezoelectric elements **326**, water can be sprayed from the nozzle holes, simultaneously. Accordingly, through one spraying, water can be applied to a broad range of the photosensitive material **16** across the entire widthwise direction thereof. As a result, it is no longer necessary to scan the nozzle plate **322** on a two-dimensional plane, and water can be applied to a larger area of the photosensitive material **16** in a short period of time, thereby minimizing the application time.

In combination with the speed at which the photosensitive material **16** is conveyed, water can be applied to the entire surface of the photosensitive material **16** by spraying water from the nozzle holes **324** for a multiple number of times at an arbitrary timing. When water is sprayed from the nozzle holes **324** of the nozzle plate **322**, the amount of water within the spray tank **312** gradually decreases. However, because a sub tank **338** can supply water into the spray tank **312** and

maintain the water in the spray tank **312** at a constant level, water is supplied from the sub tank **338** to the spray tank **312**, and the water pressure of the water in the tank **312** during atomization can be maintained at a fixed value. Accordingly, a continuous spray of water can be maintained.

Thereafter, the photosensitive material **16**, to which water as an image forming solvent has been applied at the water application section **50**, is conveyed between the pair of the endless belts **122** and **124** in the heat developing and transferring section **120** by the pair of conveying rollers **34**.

As an image is scanned and exposed to the photosensitive material **16**, the image receiving material **108** is pulled out from the image receiving material magazine **106** and conveyed by the pair of nip rollers **110**. When a predetermined length of the image receiving material **108** is pulled out, the cutter **112** cuts the image receiving material **108** to a desired length.

After the operation of the cutter **112**, the cut image receiving material **108** is conveyed by the conveying rollers **132**, **134**, **136**, **138** while the cut image receiving material **108** is being guided by a guide plate. When the front edge portion of the image receiving material **108** is nipped by the conveying rollers **138**, the image receiving material **108** is set in a waiting state immediately before the heat developing and transferring section **120**.

As described above, as the photosensitive material **16** is conveyed onto the endless belts **122** and **124**, the conveying of the image receiving material **108** is restarted, and the image receiving material **108** and the photosensitive material **16** are conveyed between the endless belts **122** and **124**, and are integrated with each other.

As a result, the photosensitive material **16** and the image receiving material **108** are laminated with each other, and nipped and conveyed while being heated by the heating plate **126**. Accordingly, a heat developing and transferring process is carried out, and an image is formed on the image receiving material **108**.

When the photosensitive material **16** and the image receiving material **108** are discharged from the pair of endless belts **122** and **124**, the peel-off pawl **128** engages with the front edge portion of the photosensitive material **16** which is conveyed ahead of the image receiving material **108** by a predetermined length, and the leading edge of the photosensitive material **16** is peeled away from the image receiving material **108**. The photosensitive material **16** is also conveyed by the photosensitive material discharging rollers **148** and is collected in the discharged photosensitive material accommodating section **150**. At this time, since the photosensitive material **16** dries immediately, there is no need to provide a heater or the like in order to dry the photosensitive material **16**.

The image receiving material **108** which has been separated from the photosensitive material **16** is conveyed by the image receiving material discharging rollers **162**, **164**, **166**, **168**, **170** and output to the tray **172**.

When a plurality of images are recorded on an image recording material through an image recording process, the processes described as below are sequentially effected.

As described above, the image receiving material **108**, which has been nipped by the pair of endless belts **122** and **124** and has been subjected to the heat developing and transferring process, and on which a predetermined image has been formed (recorded), is output from the pair of the endless belts **122** and **124**. Thereafter, the image receiving material **108** is nipped and conveyed by the image receiving material discharging rollers **162**, **164**, **166**, **168**, **170** and is taken out from the image recording device.

Next, an enlarged view of the nozzle plate **322** in the spray tank **312** according to a second embodiment of the present invention is shown in FIG. **13**, and a description thereof will now be given. Further, portions identical to those shown in the first embodiment are denoted by the same reference numerals, and a description thereof will be omitted.

As shown FIG. **13**, two staggered lines of nozzle holes for spraying water, lined up with a fixed distance therebetween in a straight line, in an orthogonal direction with respect to the conveying direction A of the photosensitive material **16**, are disposed on the nozzle plate **322** of the spray tank **312** according to the present embodiment.

Operations and effects which are similar to the first embodiment can be provided by lining up the nozzle holes **324** as described above. In addition, one spray of solvent allows for the application from two nozzle lines. Accordingly, the number of expansions of the piezoelectric elements **326** can be reduced, leading to a more efficient application becoming possible.

In the above-described first and second embodiments, the nozzle plate **322** is made by nickel electro-forging, and the water repelling layer **360** is a layer which is made by co-precipitating nickel-phosphor and polytetrafluoroethylene. However, it is not limited to this combination of materials. For example, the material of the nozzle plate **322** may be a metal such as stainless steel or the like, ceramics, silicone, glass, plastic or the like. The water repelling layer **360** may use a material such as a high polymer fluoride, a material which satisfies water repellency, or the like. Namely, it is desirable that the combination of materials prevents the nozzle plate and water repelling layer from peeling off from each other, while the surface of a water repelling layer is water repellent.

The thickness of the water repellent processing layer **360** is, for example, 3 to 5 μm. However, It is not limited to this value. Further, in accordance with the above-described embodiments, a water repellent processing layer is provided for the entire periphery of the nozzle holes. However, in cases where the water repellent processing layer is provided only on the internal portion of the nozzle hole, because operations and effects which are substantially the same as those in the first and second embodiments can be provided, the water repellent processing layer may be provided only on the internal portion of the nozzle holes. Further, the water repellent processing layer may be provided on the periphery of the nozzle holes excluding the portion of the nozzle plate on the internal side of the spray tank.

In accordance with the above-described first and second embodiments, 1 or 2 nozzle lines were provided, however, the number of nozzle lines are not limited to one or two. Accordingly, three or more nozzle lines can be formed. The larger the number of nozzle lines, the fewer the times the actuator is driven.

Further, in accordance with the first and second embodiments, the rows of nozzles are disposed orthogonally to the conveying direction of the photosensitive material **16**, however, they are not limited to this orthogonal disposition, and may be disposed diagonally to the conveying direction of the photosensitive material **16**.

In accordance with the above-described first and second embodiments, the photosensitive material **16** and the image receiving material **108** are used as an image recording material. Water is applied to the photosensitive material **16**, after the exposure thereof, by the spray tank **312** of the application device **310**. The photosensitive material **16** and the image receiving material **108** are laminated onto each

other and are subjected to the heat developing and transferring process. However, the structure is not limited to this, and water may be applied by spraying to the image receiving material **108**.

Further, an image recording material according to the present invention is not limited to the materials used in the above described embodiments. Sheet type or roll type materials can be used where suitable. The image forming solvent may be a solvent other than water. Moreover, the present invention can be employed for the application of a developer to printing paper in a developing machine, the application of dipping water in a printer, and in coating machines or the like.

As described above, in accordance with the liquid spraying apparatus and the method of manufacturing the liquid spraying apparatus of the present invention, the superior effect of the image forming solvent being prevented from leaking from nozzle holes unnecessarily can be obtained.

What is claimed is:

1. A liquid spraying apparatus which is used for an image forming apparatus and sprays an image forming solvent onto an image recording material, comprising:

a spray tank which stores the image forming solvent;

a nozzle plate with a plurality of nozzle holes connected to said spray tank for spraying the image forming solvent formed thereon, which can spray the image forming solvent from the plurality of nozzle holes by a reciprocating movement, said nozzle plate having an internal surface and an external surface, said external surface including a first portion which lies in a plane and a second portion which is bent from said first portion so as to be out of said plane, wherein each of said nozzle holes extends from said internal surface to said external surface; and

a water repelling layer which is provided at the internal periphery of the nozzle holes of said nozzle plate for repelling the image forming solvent;

wherein said nozzle plate has a concave portion which is formed in a bent shape so that the rigidity of said nozzle plate increases.

2. A liquid spraying apparatus according to claim **1**, wherein said internal surface of said nozzle plate is disposed on said spray tank as a portion of the wall surface of said spray tank.

3. A liquid spraying apparatus according to claim **1**, wherein said water repelling layer is further provided on the periphery of the nozzle holes of said nozzle plate on an external side of said spray tank.

4. A liquid spraying apparatus according to claim **3**, wherein said water repelling layer is further provided on said internal surface of said nozzle plate around the nozzle holes of said nozzle plate.

5. A liquid spraying apparatus according to claim **1**, wherein a solvent storing space in said spray tank for storing the image forming solvent has a smoothly curved cross sectional configuration so that it is difficult for air bubbles to be deposited.

6. A liquid spraying apparatus according to claim **1**, wherein at least one of said nozzle holes has a diameter on said internal surface which is larger than that on said external surface.

7. A liquid spraying apparatus according to claim **1**, wherein said nozzle plate has a row of nozzle holes formed in a straight line thereon.

8. A liquid spraying apparatus according to claim **7**, wherein said nozzle plate has a plurality of rows of nozzle holes formed in a straight line thereon, and the rows of nozzle holes are formed in a offset from one another.

9. A liquid spraying apparatus according to claim **1**, further comprising an actuator by which said nozzle plate is reciprocated.

10. A liquid spraying apparatus according to claim **9**, wherein said water repelling layer is further provided on the periphery of the nozzle holes of said nozzle plate on an external side of said spray tank.

11. A liquid spraying apparatus according to claim **10**, wherein said water repelling layer is further provided on said internal surface of said nozzle plate around the nozzle holes of said nozzle plate.

12. A liquid spraying apparatus according to claim **9**, wherein said spray tank further includes at least one tank body structural member, and at least one lever plate connected to said at least one tank body structural member by a supporting portion, such that said at least one lever plate is pivotable about said supporting portion.

13. A liquid spraying apparatus according to claim **12**, wherein said actuator includes a piezoelectric member connected between said at least one tank body structural member and said at least one lever plate.

14. A liquid spraying apparatus according to claim **12**, wherein said nozzle plate is connected to said at least one lever plate.

15. A liquid spraying apparatus according to claim **1**, wherein said water repellant layer is further provided on said inner surface of said nozzle plate around the nozzle holes of said nozzle plate.

16. A liquid spraying apparatus according to claim **5**, wherein said solvent storing space is defined by a surface bonding member on said internal surface of said nozzle plate.

17. A liquid spraying apparatus according to claim **16**, wherein said solvent storing space is further defined by an elastic member connected to said bonding member such that said solvent storing space is formed between said bonding member and said elastic member.

18. A liquid spraying apparatus according to claim **1**, wherein at least one of said nozzle holes is tapered.

19. A liquid spraying apparatus according to claim **1**, wherein at least one of said nozzle holes has a diameter on said internal surface which is larger than that on said external surface.

20. A liquid spraying apparatus according to claim **14**, wherein said actuator includes a piezoelectric member connected between said at least one tank body structural member and said at least one lever plate.

21. A liquid spraying apparatus according to claim **1**, wherein said second portion of said external surface of said nozzle plate is recessed from said first portion.

22. A liquid spraying apparatus according to claim **21**, wherein said second portion includes a first surface which lies in a plane which is parallel to that of said first portion.

23. A liquid spraying apparatus according to claim **22**, wherein said nozzle holes are located on said first surface of said second portion.

24. A liquid spraying apparatus according to claim **1**, wherein said second portion of said external surface of said nozzle plate is recessed from said first portion.

25. A liquid spraying apparatus according to claim **24**, wherein said concave portion is formed between said first portion and said second portion.

26. A liquid spraying apparatus according to claim 25, wherein said solvent storing space is defined by a surface bonding member on said internal surface of said nozzle plate.

27. A liquid spraying apparatus according to claim 26, wherein said solvent storing space is further defined by an elastic member connected to said bonding member such that said solvent storing space is formed between said bonding member and said elastic member.

28. A liquid spraying apparatus which is used for an image forming apparatus and sprays an image forming solvent onto an image recording material, comprising:

a spray tank which stores the image forming solvent, said spray tank including at least one tank body structural member, and at least one lever plate connected to said at least one tank body structural member by a supporting portion, such that said at least one lever plate is pivotable about said supporting portion;

a nozzle plate with a plurality of nozzle holes connected to said spray tank for spraying the image forming solvent formed thereon, which can spray the image forming solvent from the plurality of nozzle holes by a reciprocating movement, said nozzle plate having an internal surface and an external surface, wherein each of said nozzle holes extends from said internal surface to said external surface and said nozzle plate has a concave portion which is formed in a bent shape so that the rigidity of said nozzle plate increases;

a water repelling layer which is provided at the internal periphery of the nozzle holes of said nozzle plate for repelling the image forming solvent; and

an actuator by which said nozzle plate is reciprocated.

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